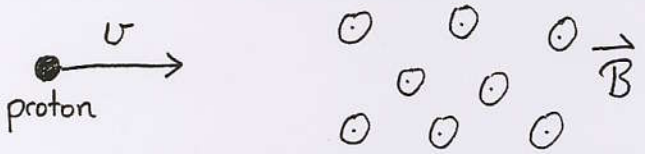
Problem 1.

A proton is moving to the right with speed v. It enters a uniform magnetic field $\vec{B}$ which points out of the page. The magnitude of B is 0.2 T.

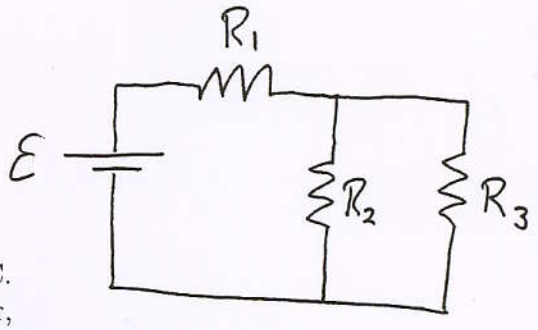


a) What is the direction of the force on the proton? (into page, out of page, up, down, to the left, or to the right)?

b) Now assume there is also a uniform electric field present in the same region. In what direction must $\vec{E}$ point if the proton is to proceed undeflected?

c) It is found that an electric field of strength 1000 V/m is needed in order that the proton not be deflected. What is the proton's speed v?

Problem 2.



Consider the circuit shown, with $\mathcal{E} = 10$ V, $R_1 = 100\ \Omega$, $R_2 = 200\ \Omega$ and $R_3 = 200\ \Omega$.

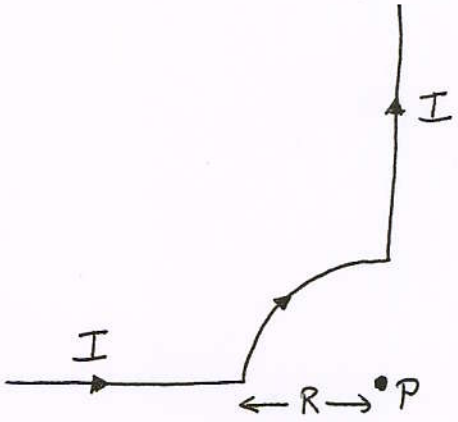
a) What is the current passing through R_1?

b) How much heat is generated in R_1 in 10 seconds?

c) If the battery were replaced by a 110 V, 60 Hz A.C. power source, and R_1 was replaced by a 122 mH inductor, what would be the peak current in the inductor?

Problem 3.

A wire carries a current I. The wire comes in straight from far away until it reaches a distance R from a certain point P, arcs around at a constant distance from that point, and then exits straight out at an angle of 90° from the incoming direction (see the diagram). Consider the magnetic field at the point P.



a) What is the contribution to the magnetic field at P from the long straight sections? If you do no calculations, briefly explain why.

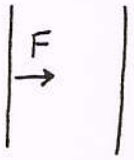
b) What is the direction of the magnetic field at P?

c) Use the Biot-Savart law to calculate the magnitude of the magnetic field at P, if $R = 50$ cm and $I = 5$ A?

4. Multiple Choice

a) Two long straight wires are parallel to each other, and each carries current. The wire on the left side experiences a force to the right. What can one say about the directions of the currents in the wires?

i) They are the same
ii) They are opposite each other
iii) Not enough information is provided

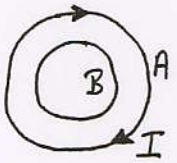


b) At some instant, a radio wave has an electric field vector pointing in the negative x direction and a magnetic field vector pointing in the positive y direction. In what direction is the wave travelling?

i) Positive x
ii) Negative x
iii) Positive y
iv) Negative y
v) Positive z
vi) Negative z
vii) Radio waves have no direction

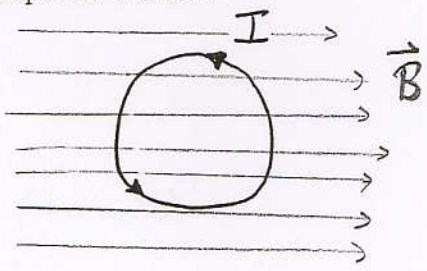
c) Two coils of wire are located concentrically in the same plane; coil A is larger than coil B. There is a clockwise, decreasing current in coil A. What is the direction of the current induced in coil B?

i) Clockwise
ii) Counterclockwise
iii) There is no current



d) A circular loop of wire is in the plane of the page, and carries a counterclockwise current. There is a magnetic field pointing to the right. What is the direction of the torque on the coil?

i) To the left
ii) To the right
iii) Into the page
iv) Out of the page
v) Up the page
vi) Down the page



e) A material is inserted into a solenoid which carries a current. The magnetic field is found to increase by a factor of 300 compared to that without the material. The material is most likely to be

i) Dielectric
ii) Paramagnetic
iii) Diamagnetic
iv) Ferromagnetic